▸ Resistance Of Corn To Aspergillus Flavus Kernel Infection And Aflatoxin Contamination

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Aflatoxins, which are produced by the fungus Aspergillus flavus, are a chronic problem for corn producers in the southeastern United States. These toxins are some of the most potent carcinogens produced in nature and are a major cause of liver cancer in humans. Initially, aflatoxin contamination of corn grain was only considered a post-harvest problem. However, field studies in 1971 and 1972 established aflatoxin contamination as a preharvest problem in corn. Historically, major aflatoxin epidemics in corn occurred in the southeastern United States in 1977 and 1998. The U. S. Food and Drug Administration limits the sale of grain with aflatoxin levels exceeding 20 parts per billion (ppb). Grain exceeding 20 ppb cannot be shipped across state lines and can only be used for livestock feed. Countries in the European Union commonly have more stringent requirements for aflatoxin levels in imported corn. Aflatoxin contaminated grain also presents a problem for the ethanol industry. Aflatoxin becomes more concentrated during the fermentation process which could make the spent grain unsuitable for livestock feed.

Environmental conditions associated with aflatoxin contamination include higher than normal temperatures during the silking/pollination period, low levels of rainfall, high night time temperatures, and high net evaporation rates. Insects are also associated with aflatoxin contamination. Ear feeding insects vector A. flavus spores into developing ears and provide entry points for the fungus at feeding sites on the kernels. Although insects have been reported to increase A. flavus infection, the most agreed upon mode of entry of A. flavus into developing corn ears is via the silks. Fungal spores produced from overwintering resting structures are disseminated by air currents and insects. Once these spores are deposited on susceptible silks, the spores germinate, and the fungus colonizes the silk tissue and grows down in to the ear. Fungal movement down the ear may be at a rapid rate at high temperatures (> 93oF).

Preharvest contamination of corn grain with aflatoxin can be prevented to some extent by implementing sound agronomic practices which limit stress to the crop. Timely planting, adequate fertility, good weed and insect control, supplemental irrigation, suitable plant population, and hybrid selection should help reduce the formation of aflatoxin in developing ears. Plant resistance is generally considered the best method for controlling A. flavus infection and subsequent aflatoxin contamination of corn grain. At this time, no commercial corn hybrids are available that are resistant to A. flavus kernel infection or aflatoxin contamination.

The USDA-ARS Corn Host Plant Resistance Research Unit is located at Mississippi State University and conducts research on the aflatoxin problem on corn. The Unit has research projects with ARS and university cooperators in North Carolina, Georgia, Louisiana, and Texas. Our research goals are to develop agronomically superior germplasm lines with resistance to aflatoxin accumulation, southwestern corn borer, fall armyworm, and corn earworm. Combining resistance to insect damage with resistance to aflatoxin contamination should provide added protection to the crop. Since aflatoxin contamination is sporadic from year to year, initial research efforts by the Unit were concentrated on developing inoculation techniques to uniformly infect corn ears with A. flavus. This led to the development of the side-needle and spray techniques that can uniformly infect plants with A. flavus spores. Once artificial inoculation techniques were developed, we were able to identify corn genotypes with resistance to A. flavus kernel infection and aflatoxin contamination. Through the use of conventional breeding techniques, our research unit has released four germplasm lines (Mp313E, Mp420, Mp715, and Mp717) that contain some of the highest levels of aflatoxin resistance that have been identified. We have also recently made progress in the area of insect resistance. Germplasm line Mp716 was released as a source of resistance to southwestern corn borer and fall armyworm. When plants in the field were infested with southwestern corn borer, hybrids with Mp716 as a parent suppressed aflatoxin contamination. We are also in the process of identifying molecular markers that are associated with aflatoxin resistance. An analysis of the mapping population Mp313E × B73 identified quantitative trait loci (QTL) on chromosomes 2 and 4 of Mp313E that contributed significantly to reduced aflatoxin contamination. An analysis of the population Mp717 × NC300 identified three additional QTL on chromosomes 1, 5, and 10 associated with reduced aflatoxin. Both Mp717 and NC300 contributed to aflatoxin resistance. Our research unit has cooperated with commercial seed companies to evaluate experimental hybrids for aflatoxin resistance. Hybrids developed from our germplasm by these companies were found to have significantly lower aflatoxin levels than currently available commercial corn hybrids. These joint efforts with the seed industry will expedite the production of commercial corn hybrids with aflatoxin resistance.

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Using Precision Agriculture And On-Farm Research To Fine-Tune Production Practices

Presented by Dr. Terry Griffin
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Each year, many farmers conduct field-scale on-farm experiments to test new products and fine-tune their production practices using precision agriculture technologies such as yield monitors and global positioning system (GPS) guidance. Three of the most important and least understood steps in conducting on-farm research include: designing the experiment, collecting site-specific data, and analyzing the data for farm management decision-making.

Farmers desire experiments that lead to quality data being collected while not requiring excessive time and efforts to implement. Experiments that are time intensive to implement or harvest may interfere with the completion of other field operations. Designs conducive to farmer-managed field-scale trials will be discussed including strip-trials, split-field,